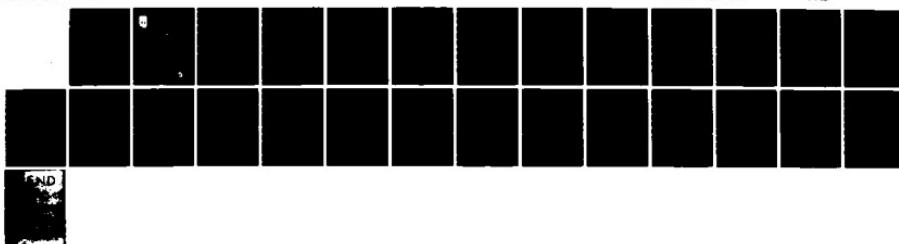
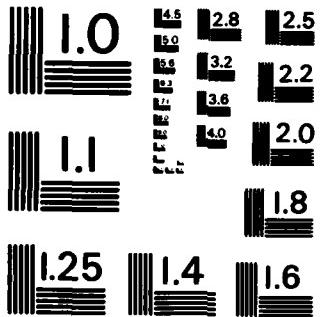


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- A REVIEW OF REC. (U) ROYAL SIGNALS AND RADAR  
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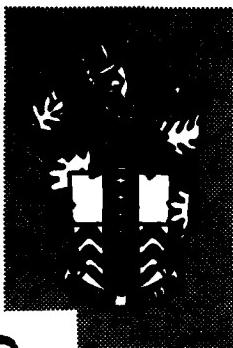




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ROYAL SIGNALS & RADAR  
ESTABLISHMENT

AIR TRAFFIC MANAGEMENT CONCEPTS FOR THE UK IN  
THE 1990s – A REVIEW OF RECENT RSRE WORK

Authors: S A N Magill and  
G Ord

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ROYAL SIGNALS AND RADAR ESTABLISHMENT

Memorandum 3714

Title: AIR TRAFFIC MANAGEMENT CONCEPTS FOR THE UK IN THE 1990s -  
A REVIEW OF RECENT RSRE WORK

Authors: S A N Magill, and G Ord

Date: June 1984

SUMMARY

This memorandum comprises 3 papers which were presented to the Eurocontrol Specialist Panel on Conflict Detection and Resolution (SPACDAR) at its meeting in Brussels, Sept 21-23 1983. They provide a record of some recent work, mainly carried out at RSRE, to generate new concepts for Air Traffic Management and Control for the UK in the 1990s. The project is sponsored by the Civil Aviation Authority, some of whose personnel are members of the team doing the work, the team being known as the Terminal Control System Development Group (TCSDG). The first paper gives a brief history and overview of the project; the two other papers deal with recent advances in two aspects of it. -- (1)

1 metering of arriving traffic and (2)

2 departure management and control .

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- PAPER 3 DEPARTURE MANAGEMENT AND CONTROL – G ORD**

Concepts for a Future System of Air Traffic Management and Control in the South-East of the United Kingdom - Introductory Paper

G Ord

History

A United Kingdom Government White Paper of 1978 on 'Airports Policy' forecast a doubling of the number of passengers using London airports between 1976 and the decade 1990-2000 and highlighted the need for a third major airport in the London area. Though a subsequent oil crisis and recession have had the effect of scaling down the original estimates, it is still expected that air movements in the 1990's will exceed one and a half times the 1983 rates. Though the subject of the third airport is still under debate it is difficult to see how such a traffic increase could be accommodated at the two present major airports without substantial use of other airports elsewhere in the London area.

With such traffic figures and the consequent change in the disposition of the traffic flow to and from the airports, it was decided that some major modifications of the existing ATC system would be needed involving all England and Wales south of approximately latitude 53N. So a joint working group was set up with its members drawn from RSRE and the planning branches of the National Air Traffic Service, the group being tasked with generating a concept for ATC in this area for the 1990's. The group is called the Terminal Control Systems Development Group usually abbreviated to TCSDG.

Since the original terms of reference, the fuel crisis of 1980 has meant that more emphasis has been put on allowing aircraft to follow economic trajectories.

The likely air environment

There are a number of constraints within which the group have had to work or which they imposed upon themselves. These are

- (i) to assume that only small increases could be made in the amount of controlled airspace available,
- (ii) that although the navigational capability of many aircraft would be improved by the 1990s, the system would still have to handle a substantial minority which did not have a much better capability than at present. This fact had an important influence on the design of route structures,
- (iii) that any system introduced in the time scale could only assume that data-link equipment will not be available for air-traffic control messages, at least, when the system is first introduced.

It is hoped that the studies undertaken may also give some indications of the influence on the design of a relaxation of some of these constraints.

The general concepts considered

In order to reduce the peak workload of the controller a more strategic approach to ATC than the present tactical one is suggested. A system based on such an approach is also more amenable to computer involvement.

The computer is used to suggest a management plan for all traffic, leaving short-term control to human controllers. In this way it is possible to overcome some of the difficulties of providing ultra-reliable software and hardware. It is also likely that such a scheme would achieve a more ready acceptance by controllers.

The extent to which the more strategic approach can be applied depends on the accuracy with which future position predictions can be made. This accuracy varies substantially with the state of each aircraft, for example whether it is airborne or still on the ground. Therefore it has been necessary to employ very different methods for management of arriving aircraft, all of which in the air environment foreseen are already airborne. This is in contrast to a management system for those departing aircraft which are not yet airborne but which are asking for engine start-up.

#### Airspace and the Design of Routes

The major problem of route design in all terminal areas is to minimise the crossing points between inbound and outbound traffic and then through each of these points to allow aircraft to fly profiles which are economic, but above all, are inherently safe. Various circulatory systems were first considered. However, it was thought that to reduce congestion in the near vicinity of the London airports it would be advisable to move holding areas further away from the London area than they are now. This should allow more space in which to climb out departing aircraft. There are a number of consequences of this philosophy. In the holding areas, aircraft must be held at higher levels; the protected airspace around the holding point is therefore more extensive. For this and other reasons such holding has turned out to be a mixed blessing and is not likely to prove so advantageous as was originally thought.

The routes used in our experiments have been designed by the airspace planning branch in the CAA. They are likely to be subject to revision in the future.

#### Work on Arrivals and Departures

To start with, the work programme was divided up into portions which were limited in scale,

- (1) an off line suite of programs to provide realistic traffic samples representative of the 1990s,
- (2) an on-line simulator for the air and ground environment complete with manual driving positions (ie pilot positions),
- (3) a departure management program dealing with aircraft at the time of "call for engine start-up",
- (4) a metering and spacing programme for arrivals,
- (5) a predictive aid for tactical intervention with departing aircraft to allow them to fly economic climb profiles which are also safely separate from the profiles flown by the metered arriving traffic.

The two accompanying papers describe the recent experiments carried out as part of the work programme listed at 4 and 5 above. Both experiments deal especially with the interface between controller and computer. The papers were originally prepared for an audience mainly composed of air traffic controllers rather than engineers.

## Metering of Arriving Traffic

S A N Magill

### 1 General Principle of Metering

The fundamental task is to convert the virtually random arrival of aircraft at the boundary of the region into as even a flow as possible at the thresholds of the airports concerned. Though theoretically it might appear that advancing the time of arrival of some aircraft might increase the overall flow, in practice, when traffic is heavy, the even flow is only likely to be achieved by delaying some or all of the aircraft. To minimise the total delay and to arrange that delays are fairly shared out between aircraft, it is necessary to take into account all the aircraft bound for the airport no matter on which route they are approaching.

In the interests of fuel economy it is important to obtain as much of the delay as possible by speed control and this implies using the largest speed change over the greatest distance. The last factor means that it will be advisable to ask for a speed change near the area boundary. Of course if substantial delays are needed these are taken in a holding pattern.

If the aircraft are allocated slots in the airport arrival sequence soon after they come over the outer boundary of the region, the aircraft on a route where the estimated earliest times of arrival at the airport are further into the future, have a greater chance of being allocated the slot they want. To get a fairer allocation of slots, it has been suggested that a fixed time horizon should be used: ie a decision on the allocation of the slots is carried out a fixed time ahead of the aircraft's estimated airport arrival time. For aircraft on some of the shorter routes this could mean that the slots may have to be allocated before the aircraft cross the outer boundary but it is thought that there will be adequate UK radar cover in this area on which to base a planned order.

The allocation of slots has been on a first come, first served basis; the estimated time of arrival at the airport being the determining factor. Such a system is not the most efficient but is in accord with present practice and is considered to be capable of gaining more ready acceptance than a scheme which, though more efficient, could be seen to penalise some classes of aircraft or aircraft companies. At a later stage it is proposed to investigate altering the order to provide more efficient use of airports and more economic performance of aircraft.

### 2 The Experimental System

An experimental system has been built at RSRE to try out various aspects of a metering system. During 1982 and 1983 it has been used to investigate the metering process and the interface between this and the human controller. Fig 1 shows a block diagram of the system. Its two main components are an Air Traffic Simulator and an Air Traffic Management System. The simulator is a suite of real-time programs which can simulate the flights of up to 140 aircraft at once. The management system is a program suite which aims to help the controller manage the traffic. An Automatic Controller Program is provided to control traffic in all the sectors not being handled by human controllers. Its actions are designed to maintain a realistic environment surrounding the controller.

The route structure used was developed by the CAA members of the TCSDG team. It provides a set of inbound routes which connect the entrypoint to the UK

with the four main London airports, and a set of six high-level holding areas well out from London, each of which can be shared by traffic bound for all four airports. In addition, departure and overflight routes are incorporated and have been designed to give minimum interaction with the arrival routes.

The first version of the experimental system was used to investigate route structures and metering processes; it conveyed control instructions from metering plans to the simulator completely automatically and the experimenter's role was a purely passive one; it handled arrivals only. The next version ran mainly automatically but allowed controllers to nominate individual aircraft for manual control. This enabled them to concentrate on the difficult and interesting problems without being burdened by masses of routine detail. We have now progressed to a stage where all the traffic in a sector is controlled manually; the system communicates metering plans to the controller; he interacts with these, and communicates control instructions to an Aircraft Control Position over a voice link. Also, the experimental system can now handle arrivals, departures, and overflights simultaneously.

### 3 The Metering Process

Fig 2 is a block diagram which shows the metering process in a system context. The process receives details of an aircraft's position and speed, and its future intentions; it makes a landing time slot allocation and a stack level allocation 20 minutes out from the airport; and it generates a plan of changes to be made to the aircraft's trajectory which will cause it to arrive at the planned time. Fig 3 shows a typical vertical profile for an aircraft in our system.

Central to the metering process is a means of calculating how long an aircraft will take to fly along a route from some start point to some end point, and also to calculate for a given time from start point to end point what speed is required. These calculations are not trivial. Mathematically, the time to traverse a portion of a route can be written as

$$T = \int_{\text{start point}}^{\text{end point}} \frac{ds}{v_G}$$

where  $v_G = |\bar{V}_{TAS} (VIAS, z) + \bar{W} (x, y, z)|$ ,

where  $v_G$  is ground speed,

$\bar{V}_{TAS}$  is the true air speed vector,

$VIAS$  is indicated air speed,

$\bar{W}$  is the wind vector

We evaluate this integral by splitting the trajectory up into a number of segments with constant properties: a cruise at constant indicated air speed, direction, and flight level; a descent at constant IAS and direction; a turn at constant IAS, bank angle, and flight level, etc., and sum the time for each. There is no direct way to calculate the speed which will cause the aircraft to take a specified time, the best we can do is to calculate the times resulting from several speed values and then use an interpolation technique to deduce the speed which will give a

specified time. The matter is further complicated by the need for aircraft to spend as little as possible of their time at low level: thus the integral must be done from end point to start point rather than in the more natural way.

The metering plan consists of a list of changes to be made to an aircraft's trajectory together with a specification of "when" and "where" these changes will be made. In current practice, when control instructions are given to an aircraft, it is not normally necessary to say "when" or "where" they will become effective, because the implication is "do it now". We believe that this method gives rise to too much variability of the points at which trajectory changes will occur, and that it will be necessary to convey the "when" or "where" to the aircraft as part of the control instruction. We prefer "where" to "when" because it can be specified accurately with fewer digits, for example "start descent to flight level 80 at 30 miles to Biggin", and this ties up well with the DME information available in the aircraft. This additional information will have a significant effect on the dialogue between controller and pilot.

#### 4 The Interface Between the Controller and the Metering Process

In the mid 1990s air traffic will still be controlled by human controllers, not computers. But the metering process detects the presence of inbound aircraft automatically, allocates resources automatically, and makes detailed plans for aircraft automatically. How then can this process which is so automatic in nature interface satisfactorily with the human controller? We see this as probably the most difficult problem with metering.

We have built an experimental interface between controller and metering with the following objectives:

- (1) To facilitate communication of metering plans to the controller.
- (2) To enable the controller to assess the safety implications of a new aircraft clearance before communicating it to the aircraft.
- (3) To allow the controller to control aircraft in ways other than those planned when he considers it necessary to do so, and at some later time to request a new plan for such an aircraft.
- (4) To allow the controller to schedule his own future activities as he wants rather than being driven along a single thread of activities by the computer.

Our experimental control position consists of a radar display and a plasma display with touch-sensitive overlay. The latter is used both as a computer-labelled keyboard, and a means of conveying small amounts of tabular data such as metering plans to the controller. The interface is designed so that the controller can get most of the information he needs from the radar display alone, and so that shifts of attention from one display to the other will be relatively infrequent; the extra information on the radar display is accommodated in some new track label formats which can be selected by appropriate touches on the plasma display. The label formats used are shown in Fig 4. By providing time until next trajectory change as part of the label, the interface allows the controller to decide for himself which aircraft he will deal with next, and which he will leave to later. The time until next trajectory change is also useful when looking for potential conflicts, as is the label format showing cleared level as well as actual level. It is not envisaged that the format giving speed will be used very often, but it could help the controller decide whether or not an aircraft was closing on another

on the same track.

Fig 5 shows the plasma display in its rest state. The upper area lists the call-signs of aircraft under control from this position, and the lower area provides a number of keys (touch areas) for invoking particular system functions. The F/L and SPEED keys change the formats of labels on the radar display, the DISP key facilitates changes to the radar display radius and centre, and the RESET key returns from any point in the dialogue to the rest menu. To find out more about a particular aircraft, its callsign is touched. Fig 6 shows what happens then. The top part of the plasma display now gives the aircraft type, EAT, delay, cleared speed and flight level, and the parts of its metering plan which have not yet been communicated to it. Note that each element of the metering plan consists of:

- (1) A position, that is, a distance to a beacon.
- (2) An action, change speed, descend, hold.
- (3) A numerical value, new speed or flight level, etc.
- (4) Occasionally a parameter specifying how the action is to be done, for example, a descent rate.

If the controller decides to communicate the next element of the plan to the aircraft, after he has done so he presses the COM key to tell the system that he has done so. The system then deletes that line from the display of the plan, Fig 7. If the controller wishes to do something with the aircraft which is different from the plan, he presses the SUSPEND key and the system records the fact; when he returns to the rest menu the system marks the aircraft callsign to remind him that the aircraft is off its plan, Fig 8. At some later time he can request a new plan for the aircraft which takes account of his changes to its trajectory. (The NEW-PLAN facility is not actually available yet, but will be shortly).

Our work on the interface between the metering process and the controller, and the interface between the controller and the pilot, still has a long way to go, but we believe that satisfactory interfaces are possible.

## 5 Future Work

- (1) Work on the interface between the controller and the metering process will continue.
- (2) Work on automatic monitoring of aircraft to give early warning of failure to meet landing slot time will continue.
- (3) The metering process itself will be developed to consider several aircraft at once, and investigate the possibility of reducing the number of conflicts inherent in the total set of metering plans, and so reduce controller workload.
- (4) There has been some suggestion that the use of high-level stack areas which are shared between airports, and which have the main routes passing through them, is adding to our problems. We propose to do a brief experiment to combine speed control and low-level holding, to try to throw some light on these problems.

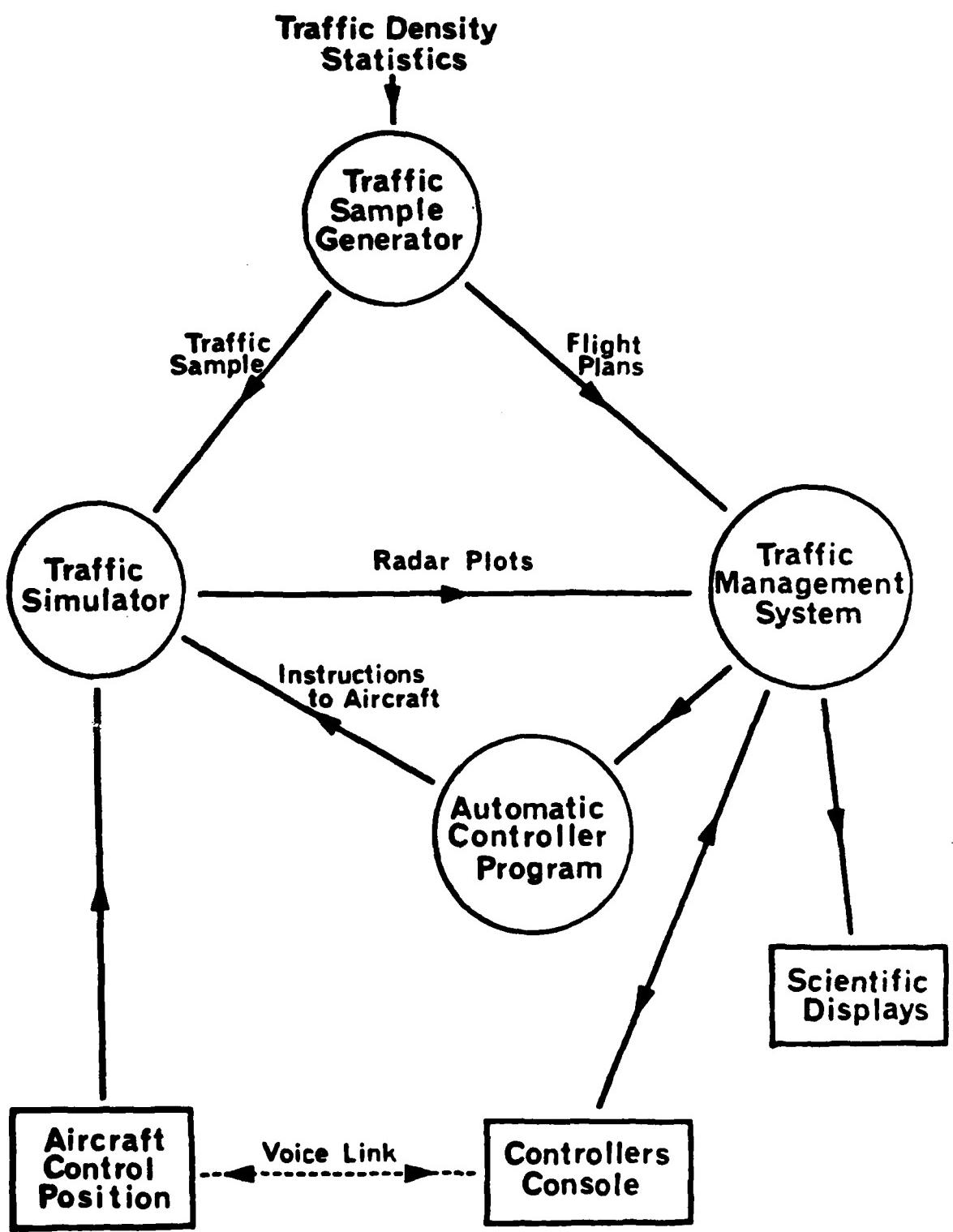


FIG 1

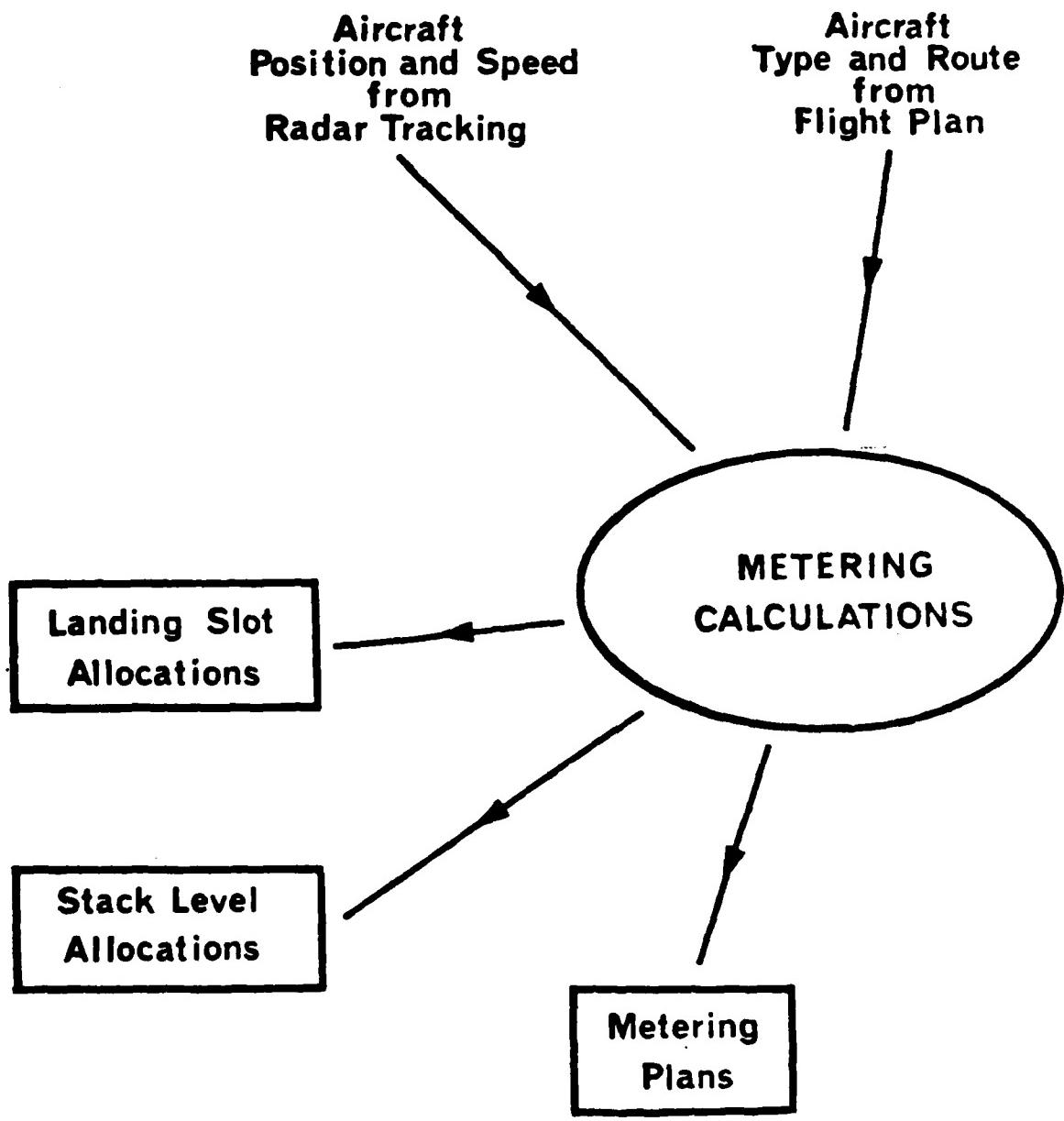


FIG 2

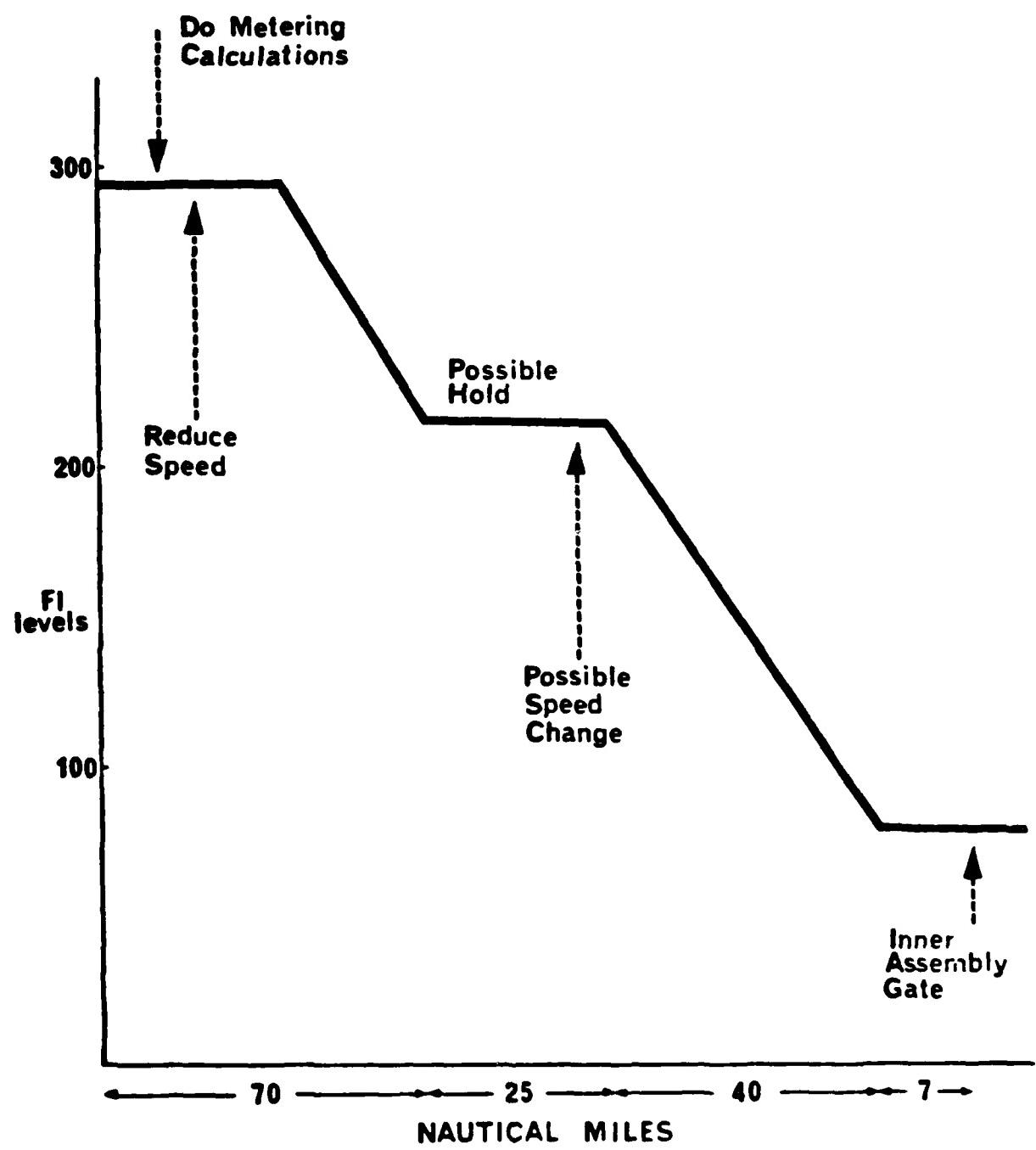


FIG 3

<p><b>BA 2345</b></p> <p><b>230 LL</b></p> <p><b>5</b></p> <p><b>Normal label with flight level and destination</b></p>	<p><b>BA 2345</b></p> <p><b>230 LL</b></p> <p><b>5*</b></p> <p><b>Next planned action has been communicated to aircraft</b></p>
<p><b>BA 2345</b></p> <p><b>230 180</b></p> <p><b>347 290</b></p> <p><b>Height label with actual and cleared levels</b></p>	<p><b>BA 2345</b></p> <p><b>230 180</b></p> <p><b>347 290</b></p> <p><b>Speed label with actual and cleared speeds</b></p>

**FIG 4**

10:10:20

SN224

LL530

JG40

BA714

AF775

AF591

JG468

---

---

DISP

SPEED

F/L

RESET

FIG 5

10:10:20

5 BNN SPEED 210 KTS

36 BNN ↓ FL 70

21 ORF ↓ FL 260

0 RFN SPEED 281 KTS

JG468 LR23 10:32:30 0:0

CL.F/L=200 CL.IAS=330

---

COMM

SUSPND

H/O

LIST

RESET

FIG 6

10:10:20

5 BNN SPEED 210 KTS

36 BNN ↓ FL 70

21 ORF ↓ FL 260

JG468 LR23 10:32:30 0:0

CL.F/L=200 CL.IAS=330

---

---

COMM

SUSPND

H/O

LIST

RESET

FIG 7

10:10:20

SN224  
LL530  
JG40  
BA714  
AF775  
AF591  
◆ JG468

---

---

---

DISP

SPEED

F/L

RESET

FIG 8

## Departure Management and Control

G Ord

### Introduction

The RSRE research programme has been considering the two main aspects of handling departures - management and control. The research started off by investigating some problems of management but over the last two years has concentrated more on experiments on tactical control. Therefore it is proposed to only give an outline of the work on management but then to deal with tactics in more detail.

### Basis of the Management Work

It is easy to foresee that with more than 2 major airports and a number of minor ones in the London terminal area, congestion and/or inefficient use of airspace or airports could readily occur. On the one hand, if the airports were allowed to operate independently, they could overload the traffic capability of one or more airways. On the other hand, if limits are set at individual airports for the departure flow rate to the various airways, and these limits do not reflect current airport and airway demand, then traffic capacity, both at the runway and on the airway, will be lost. Some form of management or co-ordination is needed to achieve the maximum output of traffic whilst retaining orderliness of traffic flow. Complete centralisation is thought to be impracticable and undesirable because of the constraints imposed on the various airfields by the interaction of landing traffic with departures, and also because it is considered that the airfields should have as much autonomy of operation as possible.

The dividing line between management and subsequent control operations can also be considered to have a time element and for departures it is presumed that management takes place before aircraft are airborne and that its aim is to provide as well-spaced a flow of traffic as possible, consistent with the maximum capacity of the system. With such management the tactical controller should not suffer the serious short-term peaks of traffic which would otherwise overload him and limit the maximum capacity of the system.

### Experiments on a departure management system

The experimental system generated aimed to remove congestion at specific points (known as the pressure points) which would otherwise result if departures are not coordinated. The pressure points are usually where departure routes merge or cross. The aim is for the controller to work out a safe and economic trajectory for each aircraft at the first opportunity at which the aircraft pilot can make a reasonable estimate of his earliest time of take-off, ie when he calls for engine start-up. The experimental equipment was designed to provide a computer driven display which, in one mode, shows the controller the total departure demands on the system. In another mode, it gives him a diagrammatic representation of the earliest possible take-off time for each aircraft and its consequent earliest arrival time at the relevant pressure points. He can compare these times with the demands of previous aircraft for time slots and can adjust the new demand to fit in as necessary. Various ways of presenting

the data have been tried. (Ref 1). As a result of demonstrating this, it was evident that it had considerable potential for use in current ATC systems and so a wholly independent experimental programme was set up with the aim of investigating the help that could be provided for the departure flow regulator position in the present West Drayton control complex. Because of this parallel development, even though it has a much shorter term objective, it has been decided to leave the departure management programme in abeyance in order to cover more fully the other aspect of handling departures, viz - tactical control.

#### The need for a more tactical approach to departures

The management of departures has, up to now, been in the context of the removal of congestion within the departures streams themselves. But a very important problem is the congestion which may occur between the departing, arriving and overflying streams of traffic. A big factor in this consideration is the relative accuracy which can be obtained when forecasting the future positions of these three different classes. There is much greater accuracy when an aircraft is airborne than when it is still on the ground, say, when the pilot is calling for engine start-up. It was therefore considered advisable to leave the detailed positional comparison between the streams to the time when all are airborne and forecasting accuracy is comparable. For departing aircraft this accuracy only becomes available when they come within radar cover and this may be only a few minutes before a possible potential conflict with aircraft in another stream. Handling now becomes more a matter of control rather than of management. Our more recent experimental work has therefore concentrated on this aspect. However, we have included an elementary management package to ensure a reasonable flow of traffic, but this works automatically.

#### The use of Standard Instrument Departure Routes

The departing aircraft from any of the airports is expected to start off by flying a Standard Instrument Departure route which keeps it safely separated from all other traffic and, in particular from the arrival streams. This can generally only be achieved by holding down the departing aircraft so that it flies below the stream of arrivals. A route structure has been designed by the airspace planning branch members of the TCSDG team to conform with this idea. Unless the departing aircraft can be cleared at an early stage to fly to much greater and more economic heights, there is a serious fuel penalty entailed. Various ways of obtaining such clearances can be designed. One is to constrain the several streams to specific height bands wherever the routes of arrivals and departures conflict in plan (the spatial approach). The aircraft fly in tubes of airspace and at any point, the airspace is dedicated to one or other streams of aircraft and there is no need for time comparison between aircraft in the different streams. This minimises the coordination needed between the controllers responsible for the different streams of traffic, and is particularly appropriate when the streams of traffic are continuous, ie there are few significant time gaps between aircraft in a stream. If traffic is more sparse such a system could be considered an extravagant use of the airspace and might also be costly in the use of aircraft fuel.

However, examination of the expected traffic pattern and density for the 1990s, as provided by the operational research branches of the UK Civil Aviation Authority (CAA), shows that there can be significant time gaps in the streams of arriving traffic on some routes and it is worth seeing how often and how easily

a controller can fit the departing traffic into such gaps. To this end a progressive series of experiments has been started using controllers in a more tactical role than previously in our departure work. An investigation is being carried out to see what kind of interactive displays could be provided to help.

#### Experiments on Manual Control of Departures

The simulation is a limited one and is a mixture of manual and automated operation. As with all our simulations a particular localised area is singled out for close attention and the remainder of the system and aircraft are handled automatically. This applies to both the air environment simulation and to the management and control system. Since the experiment is concerned primarily with departing aircraft, all the arrivals for the main London airports are dealt with by a computer program which allocates arrival slots automatically. For departures, another program arranges that all aircraft take off from their appropriate airport at correct intervals and, except for the routes which are being handled manually, the aircraft are flown and controlled automatically. Such an arrangement allows methods of control for departures on the selected routes to be investigated. Though the trajectories of the aircraft of the arriving stream through which the departures pass are determined automatically, they are typical enough of those which would occur in a future environment for the experiment to be valid.

The first experiment carried out had the aim of finding out whether there were sufficient gaps in the inbound stream to allow outbounds to filter through them no matter what the amount of tactical intervention called for from the controller. Samples of traffic were generated in accordance with the most recent forecasts made available by the operational research branches of CAA. The samples were adjusted to take into account possible new routings provided by the airspace planning branches of CAA. They reflected the traffic that could be expected on a busy July day in 1995 and included both arriving and departing traffic.

Landing slot allocation was made as arriving aircraft passed the time horizon and this generally entailed their being flown on well defined trajectories throughout the remainder of their flight. Since in nearly all cases the appearance of such aircraft at the time horizon was earlier than the take-off time of the (possibly conflicting) departing aircraft, the arriving aircraft were already committed to a plan before the departure aircraft were considered. This gave an inherent priority to arriving aircraft. Such a priority is probably right since the arrivals are flying into an increasingly constricted airspace and finally landing at their respective airports at strict minimum time intervals, whereas the departing aircraft have greater flexibility in space and certainly in time, and are more susceptible to modification.

The controller was asked to control departures along representative routes, for example on a route out of Heathrow or Gatwick to the East and South East. A section of these routes is shown, Fig 1. For the outbound traffic from Heathrow the SID route passes under the protected airspace associated with the Heathrow inner assembly point (IAP) at Ockham (OCK) and the similar point for Gatwick situated at Biggin Hill (BIG) and then crosses the stream of traffic bound from Manston to the airports of Luton and Stansted. For the departures from Gatwick there is arriving traffic merging at the inner assembly point at Burgess Hill (BGL) and crossing traffic near Lydd (LYD) and at Manston. The aim was for the

controller to climb aircraft above their SID heights as early as possible after take-off without conflicting with arrivals. In a first stage of the experiment he was provided with an equivalent to flight strips giving details of the relevant departures aircraft and also of the arriving aircraft on routes which crossed the departure routes he was responsible for.

It was soon apparent that with the forecast flow of departing and arriving traffic it was possible to climb a substantial number of departing aircraft, much earlier than was allowed for in their standard instrument departure routing. It was not uncommon for an aircraft to be allowed to climb towards its cruising level 5 minutes before it would otherwise have done if it had been restricted to its SID clearances. These figures are, at present, only based on a few runs.

However, this method of tactical control is very demanding on the controller and so subsequent experiments have been directed towards providing better methods of displaying data about both the departing and the arriving traffic. A start has been made by giving this data in a tabular form because we can provide this quickly.

Fig 2 shows traffic which has become airborne from Heathrow. As soon as a simulated aircraft is airborne, some details about it appear in the reference plaque giving call sign, type, cleared state, cruising height desired and route. The call sign is coded in a different colour so that it can be readily picked out against the other information. If the controller identifies this aircraft by using the relevant input key, more detailed data about the specific aircraft becomes available as shown in the line higher up. The controller can alter this data as is shown by the matrix display about aircraft SU93 which has been taken off its SID and has been cleared early to a level of 210. When he has, it is appropriately marked in colour.

The arriving traffic on routes which conflict with the departure route is shown on another display and Fig 3 shows one way of arranging it. There are 6 crossing points associated with the two streams of traffic bound from Heathrow and Gatwick in an Easterly direction. The upper 3 are for Heathrow departures, the lower 3 for Gatwick. They correspond to the crossings on the map shown earlier.

Expanding at one of those points. The arriving traffic is shown in green and overflights in blue. Time (in mins and seconds) and flight level at the crossing point are displayed, together with an indication if the aircraft is descending. The values are the ones forecast by the metering program. Also shown in yellow are the times and levels for the departing traffic. We are interested in seeing how the controllers use this information in deciding how and when to clear a departing aircraft above, below and through the arriving streams.

#### Plans for the Future

The display of data on departures is, at this stage, little more than an aide-memoire to the controller of the modifications he has made when entering data via the key matrix. However, the fact that such data has been entered makes it possible for the computer to work out future possible positions of aircraft resulting from the controller's data entry. A whole series of options are now possible ranging from a simple prediction tabular display to an advanced automatic conflict detection and resolution system. It is proposed to investigate

successively these more advanced and complicated systems and to assess how far it is necessary to advance before stopping at a system which is adequate for the task.

#### REFERENCE

J O Cook Work presented at the annual review of the programme of research at RSRE into Air Traffic Control Systems - June 1980

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## INBOUND V OUTBOUND EXPERIMENT

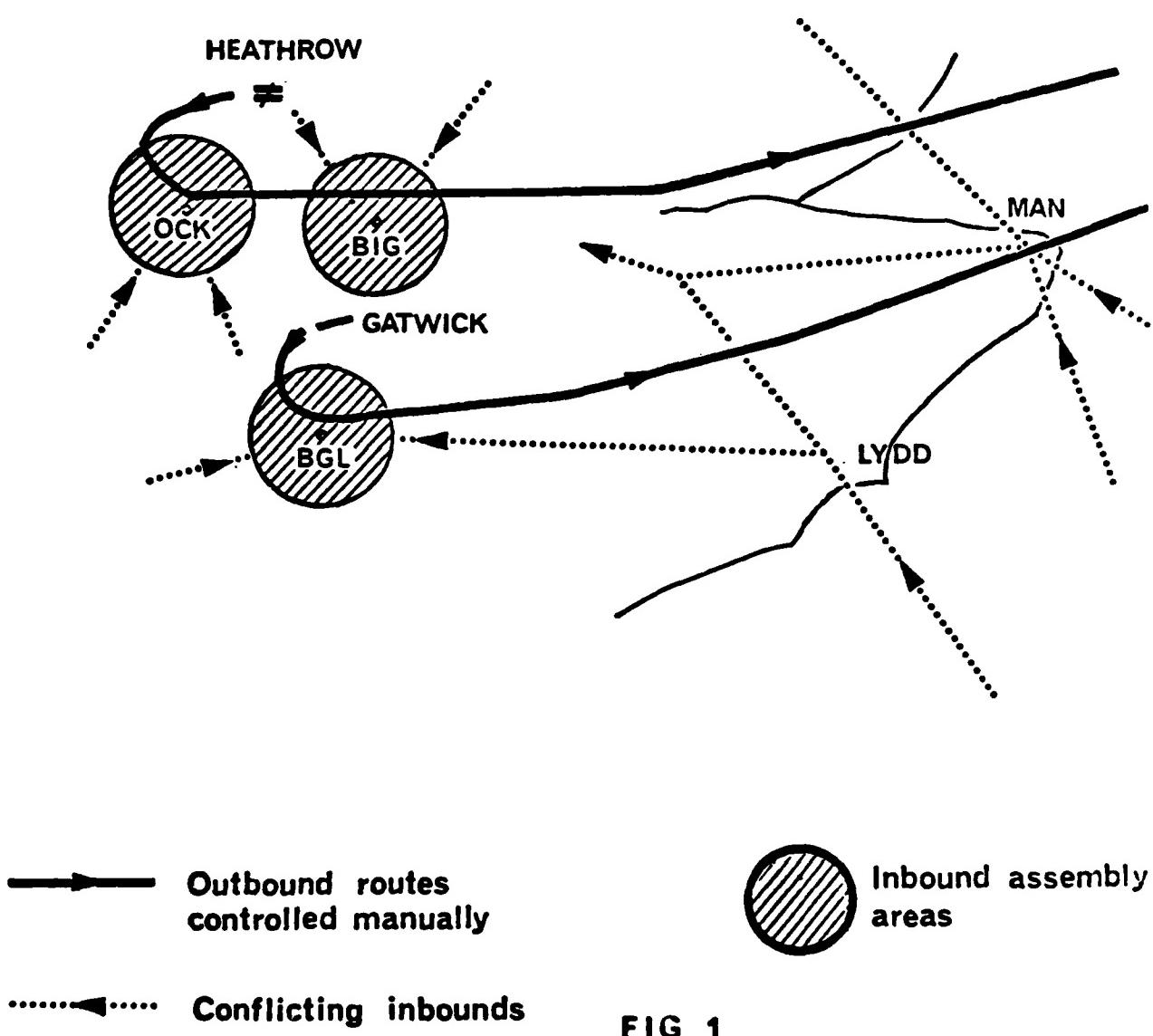


FIG 1

00:18:40

AIRPORT LL

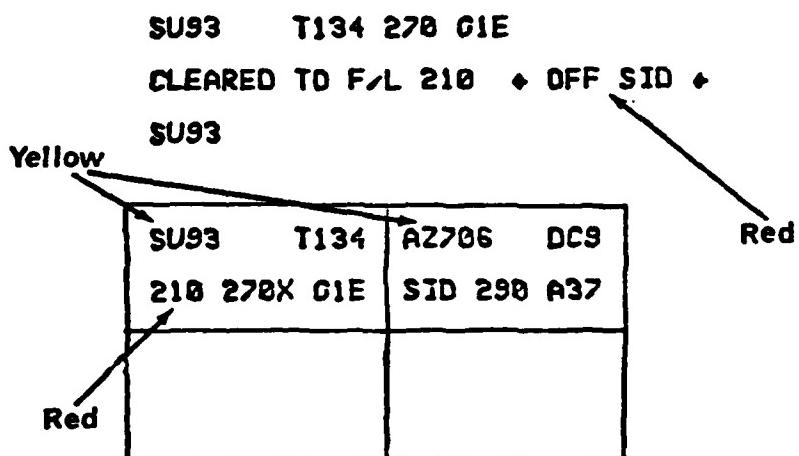


FIG 2

OCK

BIG

MAN-CFD (MAN+14)

18:20 SU93 210

22:50 KL461 060

30:40 SU93 210 ← Yellow  
28:30 BA714 192! ← Green  
25:40 BA346 240 ← Blue  
24:20 BA1020 279! ← Green

00:18:40

BGL

LYD-WML (LYD+10)

MAN

30:50 KL461 090

27:50 AF101 263!

37:30 KL461 100 ← Yellow  
26:20 BA714 230 ← Green  
23:40 BA346 240 ← Blue  
22:20 BA1020 310 ← Green

00:18:40

CONFICTING TRAFFIC FOR DEPARTURES

FIG 3

## DOCUMENT CONTROL SHEET

Overall security classification of sheet ..... **UNLIMITED**

(As far as possible this sheet should contain only unclassified information. If it is necessary to enter classified information, the box concerned must be marked to indicate the classification eg (R) (C) or (S) )

1. DRIC Reference (if known)	2. Originator's Reference Memorandum 3714	3. Agency Reference	4. Report Security Classification
5. Originator's Code (if known)	6. Originator (Corporate Author) Name and Location		
5a. Sponsoring Agency's Code (if known)	6a. Sponsoring Agency (Contract Authority) Name and Location CAA		
7. Title			
7a. Title in Foreign Language (in the case of translations)			
7b. Presented at (for conference papers) Title, place and date of conference Eurocontrol Specialists Panel on Conflict Detection and Resolution (SPACDAR), Brussels 21-23 September 1983			
8. Author 1 Surname, initials Magill, S A N	9(a) Author 2 Ord, G	9(b) Authors 3,4...	10. Date
11. Contract Number	12. Period	13. Project	14. Other Reference
15. Distribution statement <b>Unlimited</b>			
Descriptors (or keywords)			
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Abstract	This memorandum comprises 3 papers which were presented to the Eurocontrol Specialist Panel on Conflict Detection and Resolution (SPACDAR) at its meeting in Brussels, Sept 21-23 1983. They provide a record of some recent work, mainly carried out at RSRE, to generate new concepts for Air Traffic Management and Control for the UK in the 1990s. The project is sponsored by the Civil Aviation Authority, some of whose personnel are members of the team doing the work, the team being known as the Terminal Control System Development Group (TCSDG). The first paper gives a brief history and overview of the project; the two other papers deal with recent advances in two aspects of it:-  1 metering of arriving traffic and 2 departure management and control		
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**END**

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